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FACTORIAL EXPERIMENTAL DESIGN FOR DETERMINING BIOMASS THERMOCHEMICAL TREATMENT AND PURE HYDROCARBONS ADSORPTION PARAMETERS

Dimitrios K. Sidiras, Fragiskos A. Batzias, Christina G. Siontorou, Athanasia N. Bountri, Dorothea V. Politi, Odysseas N. Kopsidas, Ilias G. Konstantinou, George N. Katsamas, Ioanna S. Salapa, Stavroula P. Zervopoulou*

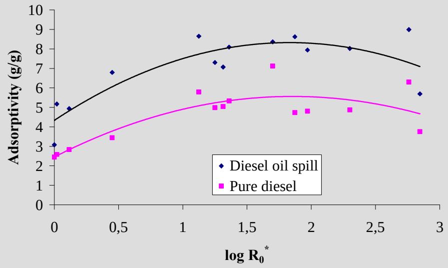
Lab. Simulation of Industrial Processes, Dep. Industrial Management and Technology, Univ. Piraeus
80 Karaoli & Dimitriou, GR 18534 Piraeus, Greece

Abstract

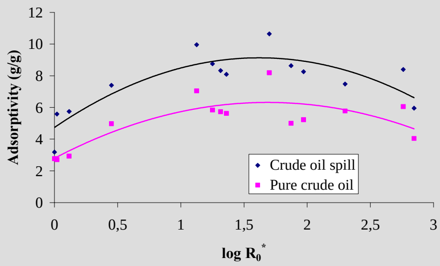
The thermochemical treatment of lignocellulosic waste biomass can provide low-cost adsorbents with increased sorption capacity and biodegradability for cleaning by adsorption the hydrocarbon spills. This work deals with the planning and carrying out the experimental measurements necessary to cover some combinations of lignocellulosic adsorbent materials and hydrocarbons to be adsorbed. The kinds of lignocellulosic waste adsorbents examined herein were selected by means of multicriteria analysis and subsequently studied with a view to correlating their physicochemical properties with surface topography and chemical composition. The SEM surface topography, the BET surface area and the XRD patterns for untreated and modified wheat straw were also studied. Optimal modification conditions, for maximizing the diesel and crude oil adsorptivity, were found by means of factorial experimental design. Diesel and crude oil spills were formed on seawater (two Ports), stream water and lake water. The diesel and crude oil adsorption on untreated and pretreated wheat straw was measured. The diesel and crude oil adsorption on pretreated wheat straw was significantly higher compared to that of the untreated material.

Severity factor values for the modification of wheat straw by maleic acid hydrolysis.

Maleic acid concentration (M)	T (°C)	t (min)	R_0	R_0^*	$\log R_0^*$
0.01	140	25	1426.9	1.05	0.019
0.01	160	0	1844.2	1.31	0.116
0.05	140	0	292.3	2.82	0.451
0.01	160	50	15494.2	13.34	1.125
0.05	140	50	2293.1	17.80	1.250
0.09	140	25	1426.9	20.63	1.314
0.09	160	0	1844.2	22.95	1.361
0.01	180	25	58237.6	50.14	1.700
0.05	160	25	9602.0	74.54	1.872
0.05	180	0	10993.2	93.57	1.971
0.09	160	50	15494.2	199.60	2.300
0.09	180	25	58237.6	575.71	2.760
0.05	180	50	92518.2	701.82	2.846



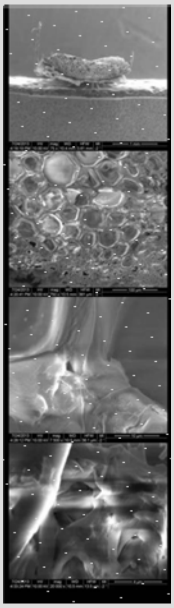
Diesel adsorbency vs. the severity factor for maleic acid modified wheat straw.



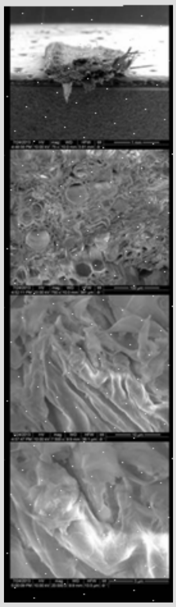
Crude oil adsorbency vs. the severity factor for maleic acid modified wheat straw.

Diesel and crude oil adsorbency of untreated and modified (by maleic acid hydrolysis) wheat straw vs. the most commonly used commercial adsorbents.

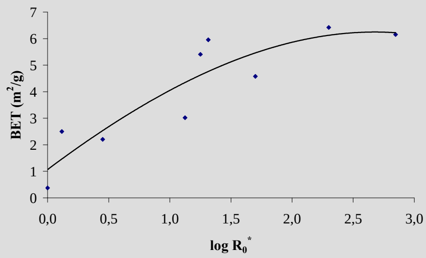
Oil	Sorbents	Adsorbency (g/g)
Crude oil	Oil adsorbent pad	12.21
	Oil adsorbent pom poms	5.06
	Untreated wheat straw	2.45
	Pretreated wheat straw	7.12
Diesel	Oil adsorbent pad	10.26
	Oil adsorbent pom poms	3.68
	Untreated wheat straw	2.77
	Pretreated wheat straw	8.19



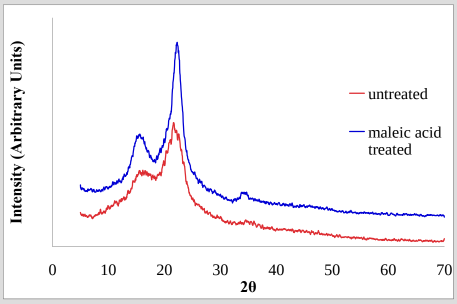
SEM images of wheat straw modified by maleic acid 0.01 M at 140 oC for 0 min. Cross section with magnifications X75, X750, X7,500 and X20,000 (increasing top-down).



SEM images of wheat straw modified by maleic acid 0.05 M at 180 oC for 30 min. Cross section with magnifications X75, X750, X7,500 and X20,000 (increasing top-down).



BET surface of the maleic acid hydrolyzed wheat straw vs. severity factor.



XRD patterns of the untreated and the maleic acid hydrolyzed (0.05 M, 180 oC, 50 min) wheat straw.

Conclusions

Experimental design for the maleic acid treatment of wheat straw was carried out. The kind of the waste-based lignocellulosic adsorbent examined herein was selected by means of multicriteria analysis and subsequently studied with a view to correlating its adsorptivity with surface topography and chemical composition. The SEM images, the BET surface area and the XRD patterns for untreated and maleic acid modified wheat straw were studied. A new severity factor log $R0^*$ was developed to incorporate the effect of maleic acid concentration, hydrolysis temperature and isothermal reaction time. Optimal modification conditions were found to maximize the diesel and the crude oil adsorptivity of maleic acid treated wheat straw. Moreover, diesel oil spills were formed on seawater (two Ports), stream water and lake water for the sampling period 2013-2014. The diesel and crude oil adsorption on untreated and autohydrolyzed wheat straw was measured. The diesel and crude oil adsorption on autohydrolyzed wheat straw was significantly higher compared to that of the untreated material.

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